NBS

Technical Note 263

DISCLOSURES ON

A Precipitation Indicator,
Moisture Detector,
Vacuum Ball Valve,
Film Strip Printer,
Normal Incidence Interferometer,
Color Sorter, and
Coaxial T

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

THE NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. Its responsibilities include development and maintenance of the national standards of measurement, and the provisions of means for making measurements consistent with those standards; determination of physical constants and properties of materials; development of methods for testing materials, mechanisms, and structures, and making such tests as may be necessary, particularly for government agencies; cooperation in the establishment of standard practices for incorporation in codes and specifications; advisory service to government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; assistance to industry, business, and consumers in the development and acceptance of commercial standards and simplified trade practice recommendations; administration of programs in cooperation with United States business groups and standards organizations for the development of international standards of practice; and maintenance of a clearinghouse for the collection and dissemination of scientific, technical, and engineering information. The scope of the Bureau's activities is suggested in the following listing of its four Institutes and their organizational units.

Institute for Basic Standards. Applied Mathematics. Electricity. Metrology. Mechanics. Heat. Atomic Physics. Physical Chemistry. Laboratory Astrophysics.* Radiation Physics. Radio Standards Laboratory:* Radio Standards Physics; Radio Standards Engineering. Office of Standard Reference Data.

Institute for Materials Research. Analytical Chemistry. Polymers. Metallurgy. Inorganic Materials. Reactor Radiations. Cryogenics.* Materials Evaluation Laboratory. Office of Standard Reference Materials.

Institute for Applied Technology. Building Research. Information Technology. Performance Test Development. Electronic Instrumentation. Textile and Apparel Technology Center. Technical Analysis. Office of Weights and Measures. Office of Engineering Standards. Office of Invention and Innovation. Office of Technical Resources. Clearinghouse for Federal Scientific and Technical Information.**

Central Radio Propagation Laboratory.* Ionospheric Telecommunications. Tropospheric Telecommunications. Space Environment Forecasting. Aeronomy.

---

* Located at Boulder, Colorado 80301.

** Located at 5285 Port Royal Road, Springfield, Virginia 22171.

NATIONAL BUREAU OF STANDARDS

Technical Note 263

ISSUED JUNE 18, 1965

DISCLOSURES ON

**A Precipitation Indicator,
Moisture Detector,
Vacuum Ball Valve,
Film Strip Printer,
Normal Incidence Interferometer,
Color Sorter, and
Coaxial T**

Editors: David Robbins and Alvin J. Englert

NBS Technical Notes are designed to supplement the Bureau's regular publications program. They provide a means for making available scientific data that are of transient or limited interest. Technical Notes may be listed or referred to in the open literature.

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402 Price 25 cents.

TABLE OF CONTENTS

This booklet presents descriptions and drawings of seven devices, embodying interesting and unusual solutions to problems frequently found in their respective fields: a selective precipitation indicator system; a capacitance-type moisture detector; an apparatus for printing copies from film strips; a normal incidence interferometer; an apparatus for color sorting small, irregularly-shaped articles; and a coaxial T for radio-frequency voltmeter calibrations.

Other disclosures on various subjects may be found in NBS Technical Notes 237 and 253.

Tech. Note No. 263, June 18, 1965

A CAPACITANCE-TYPE MOISTURE DETECTOR

Richard C. Peck

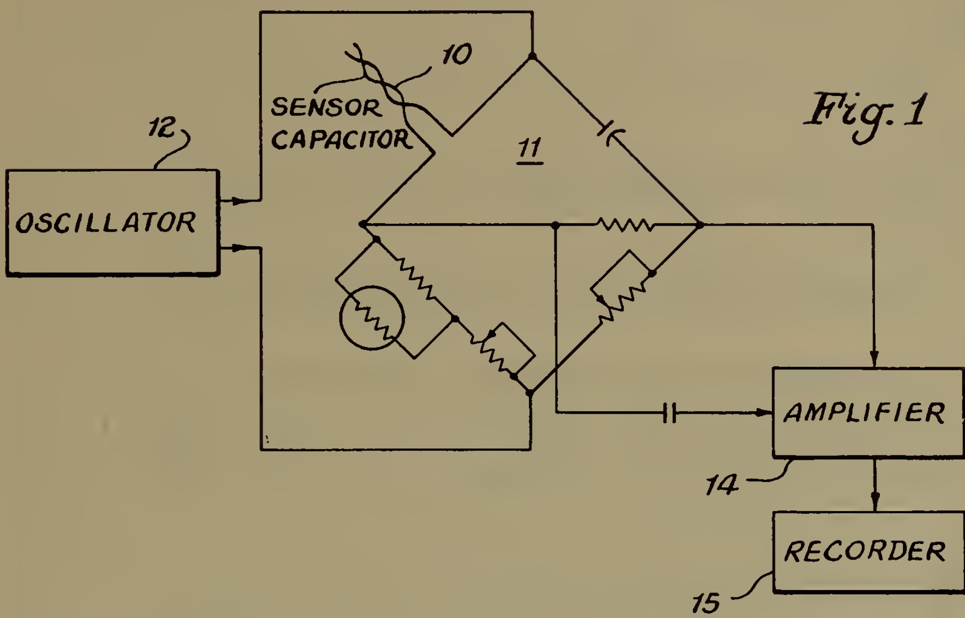


Fig. 1

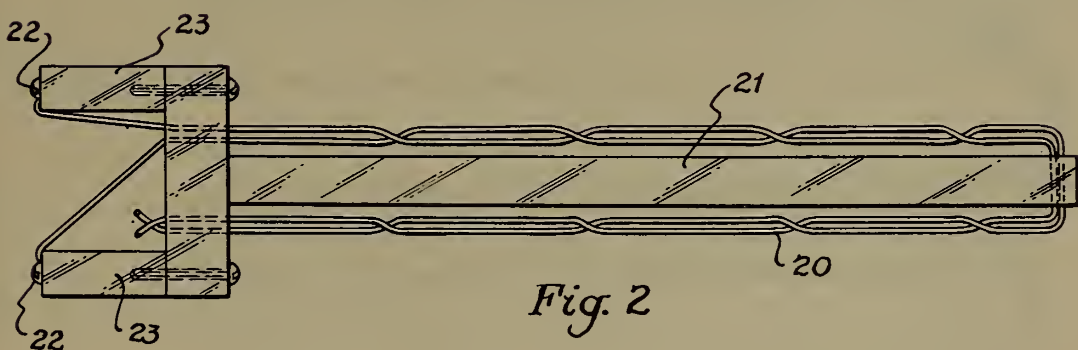


Fig. 2

Tech. Note No. 263, June 18, 1965

A CAPACITANCE-TYPE MOISTURE DETECTOR

Richard C. Peck

Fig. 3

Fig. 4

A CAPACITANCE-TYPE MOISTURE DETECTOR

Richard C. Peck

This disclosure concerns a detector of moisture either by precipitation or immersion. The detector uses a sensor in the form of a capacitor whose dielectric constant and resulting capacity increases by the addition of moisture. The sensor comprises two lengths of Teflon insulated wire loosely wound together to form two electrically separate conductors or capacitor plates.

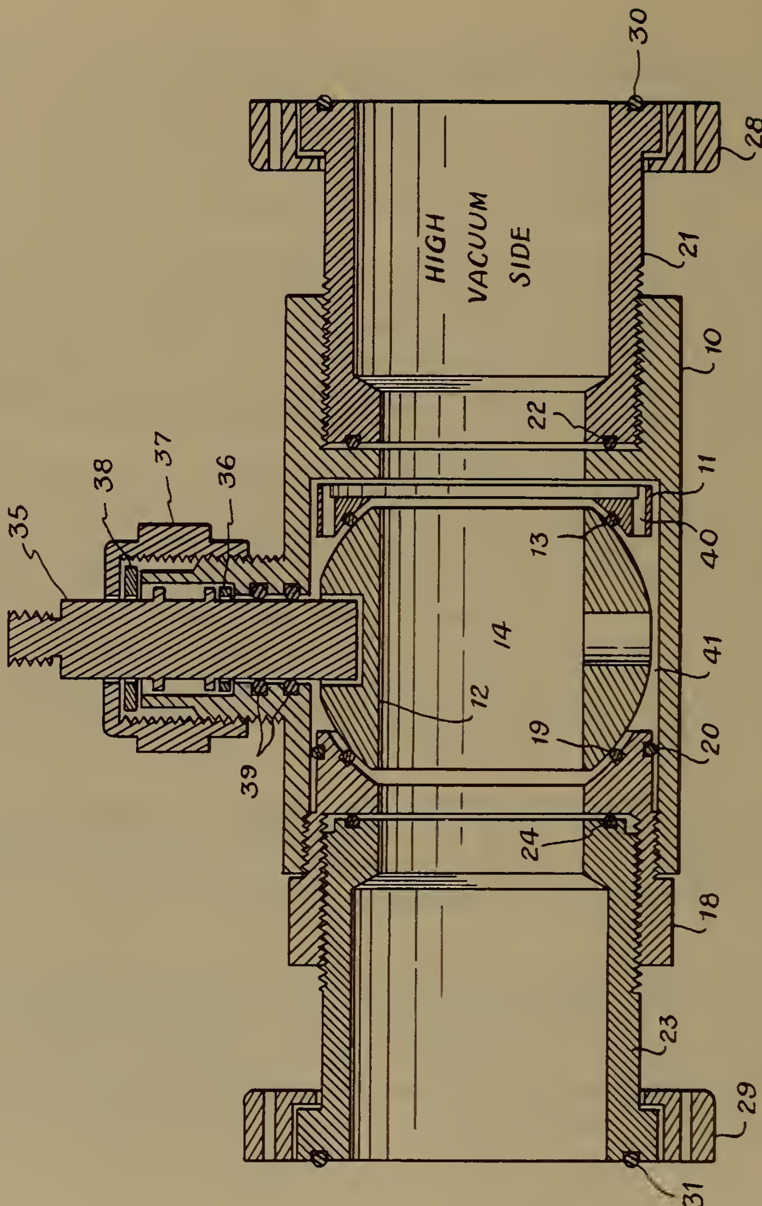
The sensor-capacitor 10 (Fig. 1) forms one arm of a bridge circuit 11 which is powered by the output of oscillator 12. The bridge is balanced to minimum output when the sensor is dry. An increase in moisture on the sensor increases its capacity thereby unbalancing the bridge circuit to cause an increase in signal output. This signal is amplified by amplifier 14 and is transmitted to recorder 15.

The physical mounting and configuration of the Teflon insulated wires depends upon the application of the detector. In the sensor in Fig. 2, the insulated wires 20 are supported on a slender plastic rod 21. One end of each wire is connected to a terminal 22 mounted on one of the ceramic pillars 23. This sensor may be inserted in the earth or other hygroscopic substance to detect the change in moisture content or it may be partially immersed in a body of liquid to show level changes. A miniaturized version can be inserted in a small hole drilled in a tree to detect the rise and fall of sap and water.

For the detection of hydrometeors, the Teflon insulated wires 30 (Fig. 3) are arranged in the form of a grid which is firmly mounted on a polystyrene plate 31. One end of each wire is connected to a terminal 32 situated in a ceramic pillar 33 in the plate.

In Fig. 4, the Teflon insulated wires 40 are supported on a skeleton framework 41, formed of plastic. One end of each wire is tied to a terminal 42 that is located in a ceramic pillar 43 positioned in the framework. This type of sensor can be buried in the ground to detect changes in soil moisture or can be submerged in a bin of grain to indicate sweating or drying out.

Tech. Note No. 263, June 18, 1965


HIGH
VACUUM
SIDE
30
28
21
10
22
11
40
13
41
14
12
19
20
24
18
23
29
31
35
38
37
36
39

A HIGH VACUUM BALL VALVE

Nathaniel J. Roper

The ball valve is named for the finely machined sphere in which a large diameter hole is drilled along one axis. In this configuration the valve inherently offers a lower pumping impedance, which is a major design criterion in high vacuum systems. This high conductance construction also provides a minimum surface for contamination.

The ball valve is operated by a double "O" ring sealed shaft which assures the maintenance of the vacuum seal. A shaft rotation through 90° describes a complete operation of the valve and thus the operation is easily adaptable either hand or automatic operation. If it is desired, a partial rotation of the shaft will effectively and gradually reduce the conductance of the valve. The sphere is effectively sealed in either the fully open or fully closed position and will maintain a vacuum in either position.

To assemble the valve, holding ring 11 is positioned in body 10, sphere 12 is placed in the body in contact with "O" ring 13. The sphere has a hole 14 drilled along one axis. Sealing ring 18 is then screwed into the body until "O" ring 19 engages the sphere and "O" ring 20 is in contact with the body. Closing flange 21 is screwed into body 10 until "O" ring 22 engages the body, and closing flange 23 is screwed into the sealing ring 18 until "O" ring 24 engages the ring.

Clamping discs 28 and 29 are positioned around flanges 21 and 23, respectively. These flange seats are designed to permit the valve to be placed in a position desired by the installer relative to screw threads or bolt holes. Finally, "O" rings 30 and 31 are set in flanges 21 and 23, respectively.

Chamber evacuation has been incorporated in the design to eliminate the inherent pressure differential around the ball, which would be released to the vacuum system when the valve is operated. The chamber is evacuated to the high vacuum side and maintained at a comparable level. There is a passage 40 in holding ring 11 between chamber 41 around sphere 12 and the high vacuum side of the valve. Thus, the chamber is subject to continuous vacuum pumping at the lowest pressure, and this continuous vacuum on the stem sealing insures freedom from external contamination.

Tech. Note No. 263, June 18, 1965

777-656 O-65—2

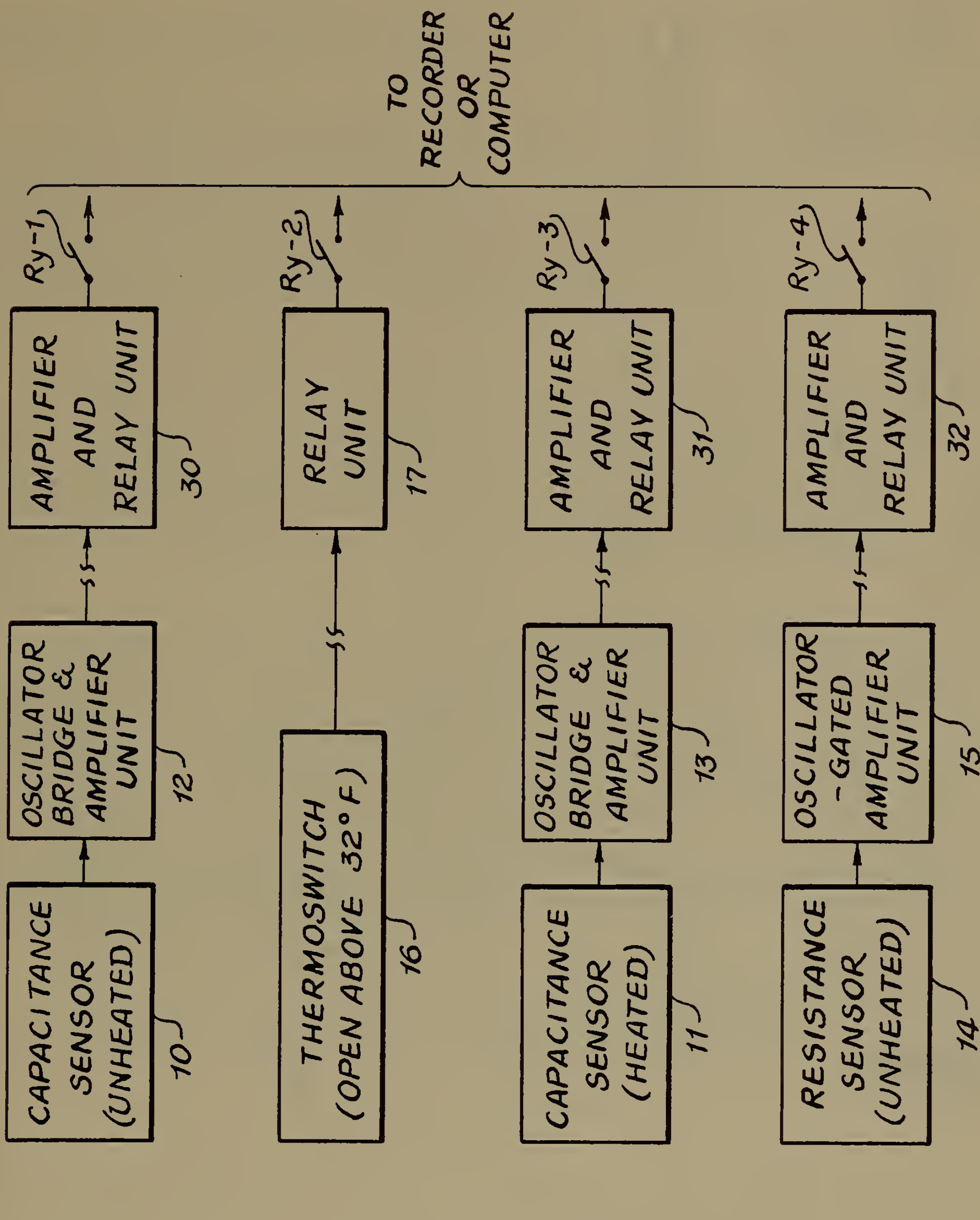
Stem 35 has one end that extends into a notch in sphere 12. The stem, resting on a Teflon collar 36 located on a flange in body 10, is held in place by nut 37 and washer 38. The "O" rings 39 and collar allow the operation of the stem without loss of vacuum.

It will be observed that "O" rings have been placed to seal all screw threads, thereby decreasing the pump down time of the valve as well as the surfaces available for contamination. It should also be noted that all of the parts which will experience wear are "O" rings and are readily replaceable.

This valve should be applicable to pressure ranges of 10^{-8} torr. It should have a rapid pump down time, no pressure differential in operation, and a minimum of pumping impedance. Its maintenance is convenient and the replacement parts are all standard stock items. The valve has the inherent capabilities of even lower pressures when materials for "O" rings become available with a lower vapor pressure than 10^{-8} torr.

A SELECTIVE PRECIPITATION INDICATOR SYSTEM

Richard C. Peck
Elbert W. Atkins



Tech. Note No. 263, June 18, 1965

Richard C. Peck
Elbert W. Atkins

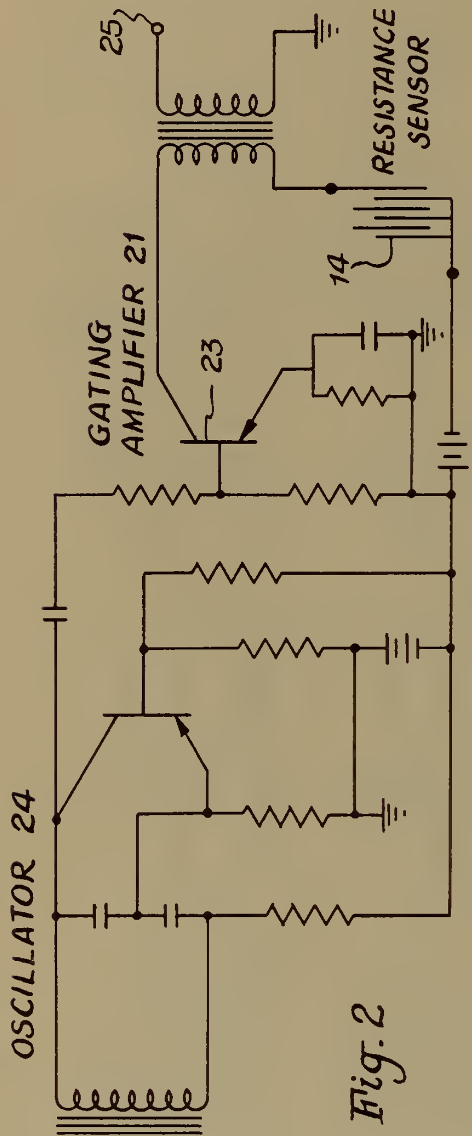


Fig. 2

PRECIPITATION FORMS	CODED OUTPUTS			
	Ry-1	Ry-2	Ry-3	Ry-4
DEW, LIGHT	1	0	0	0
DEW, HEAVY	1	0	0	1
FROST	1	1	0	0
RAIN	1	0	1	1
SNOW	1	1	1	0
FREEZING RAIN OR MELTING SNOW	1	1	1	1

Fig. 3

A SELECTIVE PRECIPITATION INDICATOR SYSTEM

Richard C. Peck
Elbert W. Atkins

This note describes a selective precipitation sensing system capable of identifying and indicating dew, frost, rain or snow as such. In addition some indication of freezing rain or melting snow is provided.

A block diagram of the system is shown in Fig. 1. The capacitance sensors 10 and 11 and the oscillator, bridge and amplifier units 12 and 13 are described in the disclosure entitled "A Capacitance-Type Moisture Detector" by Richard C. Peck, starting on page 1 of this NBS Technical Note. Heated capacitance sensor 11 is similar to the one in Fig. 4 of the latter disclosure and is mounted on a small metal box containing a 100 watt heating element and a control thermostat.

Thermoswitch 16 may be any weather proof, fast-acting thermoswitch so adjusted that its contacts are open at temperatures above 32°F and closed at temperatures below that point. The contacts of the thermoswitch are connected in series with a relay and the output of a power supply in relay unit 17. Thus, when the contacts of the thermoswitch are closed, the relay in 17 is energized and contacts Ry-2 are closed.

The resistance sensor 14 and oscillator-gated amplifier unit 15 are shown in detail in Fig. 2. Resistance sensor 14 is a bare metal grid mounted on a Bakelite plate with two sets of electrically separate and alternately positioned fingers. The normally high resistance between the two sets of fingers is lowered by the presence of moisture on the surface of the plate. The resistance sensor 14 controls the gain of gating amplifier 21 by acting as a moisture controlled variable series resistor in the collector circuit of transistor 23. When the sensor 14 is wet, the signal generated by oscillator 24 appears on output terminal 25. There is no output signal when the sensor is dry.

The resistance sensor 14 (Figs. 1 and 2) responds only to water in liquid form such as dew, rain or melting snow. It does not respond to frost, snow other other forms of frozen precipitation.

The unheated capacitance sensor 10 (Fig. 1) responds to all forms of precipitation, liquid or frozen.

The heated capacitance sensor 11 responds to rain, snow and sleet but, because it is heated, will not respond to small amounts of precipitation such as dew or frost.

The output of each unit 12, 13 and 15 is sent to a respective one of the amplifier and relay units 30, 31 and 32. In each of the latter units, the received signal is amplified, rectified and is then applied to an Artz bridge to control a relay Ry-.

The system shown in Fig. 1 operates as follows: Light to moderate dew formation will cause the unheated capacitance sensor 10 to close relay Ry-1. Sensors 11 and 14 and thermoswitch 16 will not respond. The coded output for dew is, therefore, 1-0-0-0. (See Fig. 3.) Heavy dew deposits will be detected by sensors 10 and 14. Relays Ry-1 and Ry-4 will close. The output code for heavy dew is 1-0-0-1. Drizzle will also give this indication and must be so interpreted during daylight hours.

Frost will activate sensor 10 and the 32° thermoswitch 16. The coded output for frost is 1-1-0-0. Rain will be detected by all sensors, but not thermoswitch 16. The output code for rain is therefore, 1-0-1-1. Snow will be detected by all sensors except the unheated resistance sensor 14. The code for snow is 1-1-1-0. Freezing rain or melting snow would normally operate all sensors and the thermoswitch to indicate a code of 1-1-1-1. Such an indication would be of short duration and might intermittently indicate rain or snow.

The code outputs for the more usual forms of precipitation are summarized in the table in Fig. 3.

A simple system designed to differentiate between rain and snow only would consist of resistance sensor 14 and heated capacitance sensor 11. The output code for snow would be 1-0 and 1-1 for rain.

Another system for rain or snow would consist of the heated capacitance sensor 11 and thermoswitch 16. The code for rain would then be 1-1 and for snow 1-0.

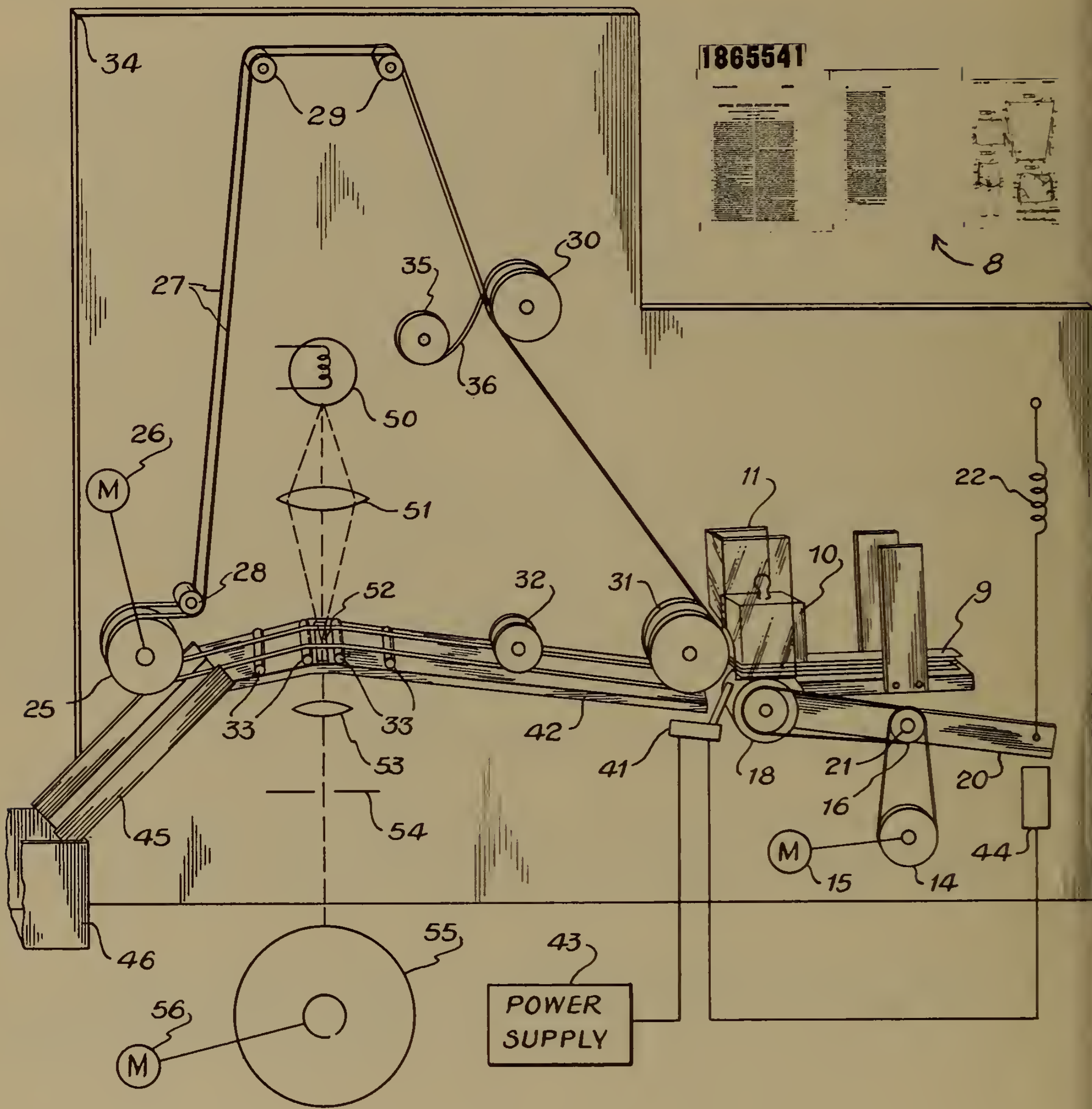
The occurrence of either dew or frost can be identified and indicated by a system composed of the unheated capacitance sensor 10 and thermoswitch 16. The code for dew would be 1-0 and 1-1 for frost. A system consisting of unheated capacitance sensor 10 and unheated resistance sensor 14 can also identify dew or frost as such.

The sensors in the systems outlined above would, of course, utilize the associated circuits shown in Fig. 1.

The selective precipitation indicator systems described herein can be used to activate bells, alarms, lights, recorders, window and door mechanisms or turn on frost inhibiting devices in fruit and vegetable growing areas. The coded output can be fed to computers for eventual printout or can be retransmitted by radio or wire to remote points.

APPARATUS FOR PRINTING COPIES FROM FILM STRIPS

Frank R. Oliveri
Anthony A. Berlinsky
Allen H. Sierer



APPARATUS FOR PRINTING COPIES FROM FILM STRIPS

Frank R. Oliveri
Anthony A. Berlinsky
Allen H. Sierer

This apparatus may be used in a large library to supply copies of reference documents on demand by reproducing the copies from strips of microfilm containing the documents.

In a system using the apparatus a reference document is microfilmed the first time it is requested. After the film is processed, it is cut into short pieces having lengths that depend on the number of frames or document pages. Where the average number of pages per document is, for example, six, the microfilm may be cut into strips containing three to eight frames. If the document contains twenty-five pages, the film is cut into five strips, each having five frames, or into three strips, each having six frames and one strip having seven frames. Documents containing only one or two pages are provided with blank frames to keep the strips to a minimum 3-frame size. The film-strips are stored in a suitable file cabinet.

A variety of techniques may be used to simplify handling the film-strips. A large size configuration of the document's number, for example, may be photographed above the first frame of each strip, as illustrated by strip 8. The number is sufficiently large to make it easily visible to any one searching the files. The reading of the document number is also facilitated by using a single white paper jacket or envelope that encloses only the bottom portion of the film strip and thus provides a white background so that the number can be easily read. The paper jacket holds the strip flat preventing any tendency to curl and simplifies the handling of a small strip.

After the film strips have been prepared, an order is filled for a number of documents by going to the file, selecting the proper strips 9 and placing them under weight 10 in magazine 11 in the figure.

Pulley 14 is driven continuously by motor 15 and in turn drives pulley 16. The latter pulley drives guide roller 18 which is mounted on arm 20. The arm pivots on shaft 21 and is biased counter-clockwise by spring 22. Pulley 25 is continuously driven by motor 26 and in turn drives the film-belts 27 which are guided by rollers 28 to 33. The spool 35 is adjusted so that spring 36 will urge guide roller 30 against belts 27, placing them under proper tension. The arm of microswitch 41 passes through film slide 42. Frame 34 is used to mount several of the components in the figure.

In operation, roller 18 transports the first film strip 9 under roller 31 and then under belts 27. When the strip depresses the arm of microswitch 41, the circuit from power supply 43 to solenoid 44 is broken, the solenoid is de-energized and arm 20 is pivoted counter-clockwise in the figure so that roller 18 can not feed another strip. As the trailing edge of the first strip 9 passes the arm of microswitch 41, the arm is released, solenoid 44 is energized and arm 20 rotates the roller 18 clockwise. The roller then engages the second film strip 9, moving it under belts 27. In this way, the strips are transported in a continuous stream across slide 42 and down chute 45 into container 46.

The light, provided by lamp 50, is focused by lens 51 to illuminate each frame in the film strips 9 as they pass over slit 52. The frames are then projected by lens 53 and slit 54 onto the charge, photo-conductive surface of the drum 55 so that electrostatic images are retained on the surface. The drum is driven by motor 56 and the images are transferred to printing paper to make positive copies by means of well-known xerographic techniques.

APPARATUS FOR COLOR SORTING SMALL, IRREGULARLY-SHAPED ARTICLES

Vernon J. Hurst

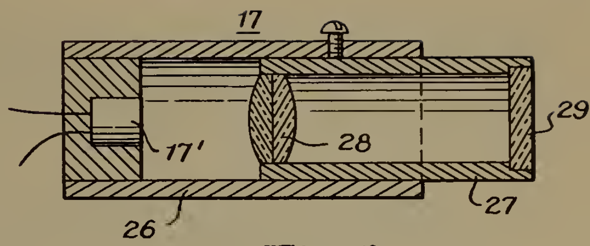


Fig. 2

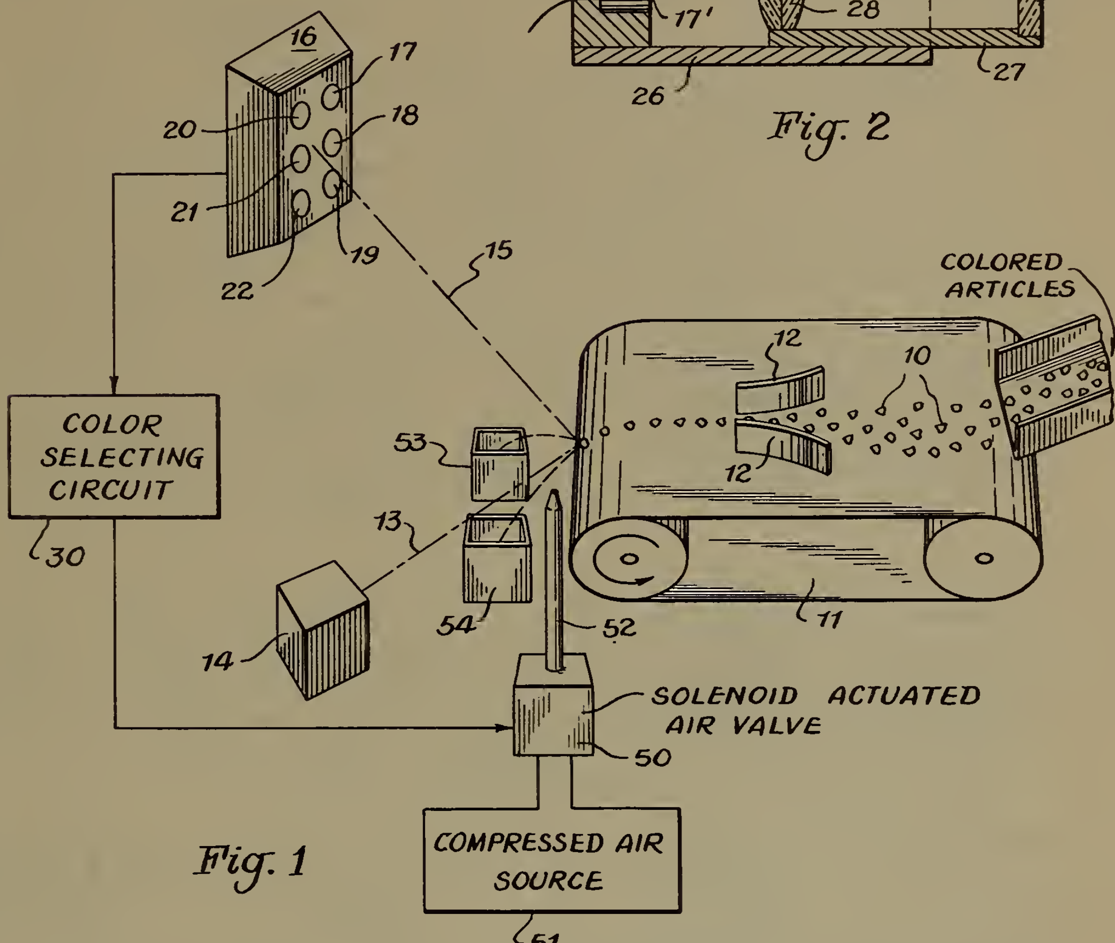


Fig. 1

APPARATUS FOR COLOR SORTING SMALL,
IRREGULARLY-SHAPED ARTICLES

Vernon J. Hurst

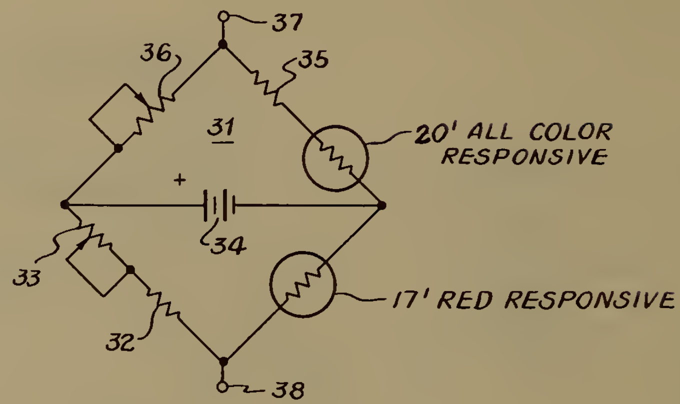


Fig. 3

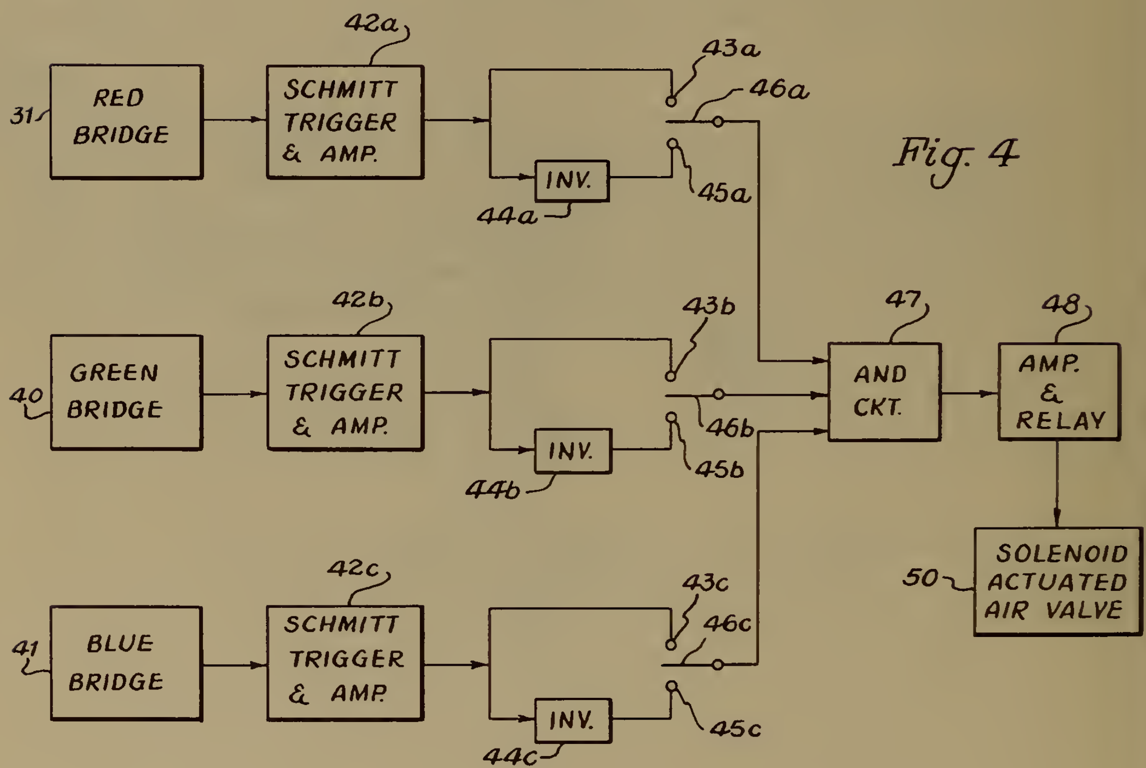


Fig. 4

APPARATUS FOR COLOR SORTING SMALL, IRREGULARLY-SHAPED ARTICLES*

Dr. Vernon J. Hurst

It often is desirable to sort small, irregularly-shaped, colored articles, such as fragments of crushed stone, agricultural products and the like, into groups of like color. The apparatus shown in Fig. 1 automatically performs such a sorting.

In Fig. 1, colored articles 10 to be sorted are fed onto a conveyor belt 11 having guides 12 which arrange the articles in spaced, sequential order. As each article nears the end of the conveyor belt 11, it passes into a collimated beam of white light 13 projected by a suitable source 14. The light 15 reflected by an article in the beam is incident on a photo converter 16 which converts the colors of the light 15 into electrical signals. The signals are fed to a color selecting circuit 30 which determines whether the article in the beam 13 is of the desired color. If it is, a signal is fed to a solenoid-actuated air valve 50 which permits compressed air from source 51 to enter tube 52 and blow the article laterally into a receptacle, conveyor or the like 53 of articles of the selected color. If the color selecting circuit 30 determines that the article in the beam 13 is not of the selected color, no signal is supplied to the valve 50, and the article falls freely into a receptacle or conveyor 54 of rejected articles.

The photo converter 16 of Fig. 1 comprises six photoconductive cell units 17-22. The unit 17, shown in Fig. 2, consists of a photoconductive cell 17' mounted in the far end of a tube 26 which telescopes with another tube 27 containing an objective lens 28 and a filter 29. The filter 29 in unit 17 is red-transmissive; in unit 18 the filter is green-transmissive; in unit 19 the filter is blue-transmissive; and in units 20, 21 and 22 the filter is omitted. Thus the photoconductive cells 17', 18', and 19' in units 17, 18 and 19, respectively, receive only the red, green and blue components, respectively, of the reflected light 15, while the photoconductive cells 20', 21' and 22' each receive all of the light 15.

*Developed at the University of Georgia under Area Redevelopment Agency Technical Assistance Contract No. Cc-6094.

The units 17-22 are each mounted in the photo converter 16 so as to face the article in the projected beam 13, and the telescoping tubes thereof are adjusted so that the lenses image the article on the associated photoconductive cells 17'-22'.

In the color selecting circuit 30 of Fig. 1, the six photoconductive cells 17'-22' are connected as pairs into three bridge circuits. The bridge circuit 31 shown in Fig. 3 includes the cell 17' which is preceded by a red filter, and the cell 20' which receives the unfiltered light 15. The photoconductive cell 17' is connected in series with a resistor 32, a potentiometer 33, and a direct current source 34. The potentiometer 33 adjusts the operating current through the photoconductive cell 17', while resistor 32 limits the maximum current to a safe value. When the incident light 15 contains red components, the resistance of cell 17' decreases, causing the voltage drop thereacross to decrease.

The photoconductive cell 20' is connected in series with a current-limiting resistor 35, a current-adjusting potentiometer 36, and the source 34. Since the cell 20' receives all of the light 15, the voltage drop across cell 20' decreases as the amount of the light 15 increases.

Output terminals 37, 38 for the bridge circuit 31 are taken at the junctions 35-36 and 17'-32, respectively, whereby the voltage drops across the cells 17' and 20' are effectively subtracted to obtain the bridge output voltage. Thus the voltage across terminals 37, 38 tends to vary as the intensity of the red components of light 15, minus the intensity of the total components of light 15. As will be apparent hereinafter, it is desirable that this output voltage exceed a minimum or threshold value when the light 15 is reflected by a red article of minimum size. Hence the voltage variations due to the intensity of the total components are attenuated by suitably increasing the resistance of potentiometer 36, with such a minimum-sized red article maintained in the projected beam 13. Thus the bridge output voltage varies as red intensity minus a fraction of the total intensity. From the latter expression, it follows that the output voltage will exceed the threshold value when the incident light 15 is predominantly red. It further follows that highly-reflective (shiny) non-red articles cannot produce a spurious voltage exceeding the threshold voltage. This is an especially valuable feature when sorting irregularly-shaped articles such as rock fragments.

The green-responsive cell 18' and all-color-responsive cell 21' are connected into a bridge circuit (not shown) similar to bridge 31, as are the blue-responsive cell 19' and all-color-responsive cell 22'.

In Fig. 4, the voltages produced by the red, green and blue bridge circuits 31, 40 and 41 are applied to conventional Schmitt trigger circuits 42a, 42b and 42c, respectively. When any of the bridge voltages reaches the aforementioned threshold value, the associated Schmitt trigger switches from zero output to full output, thereby sharpening the bridge signal. The output of each Schmitt trigger preferably is amplified to obtain a strong driving signal. Each driving signal is then fed to a respective switch contact 43a, 43b and 43c, and to a respective conventional inverting circuit 44a, 44b and 44c. The outputs of the inverting circuits 44a, 44b and 44c are fed to switch contacts 45a, 45b and 45c, respectively. Switch arms 46a, 46b and 46c are provided to connect to either the driving signals on contacts 43a, 43b, 43c or the inverted driving signals on contacts 45a, 45b, 45c. All of the switch arms 46a, 46b and 46c are connected to a conventional logical AND circuit 47, which produces an output only in the event that signals are present on all three of the switch arms. The output of the AND circuit 47 is fed to a conventional amplifier and relay circuit 48 adapted to energize the solenoid-actuated air valve 50 (see also Fig. 1).

In the operation of the circuitry of Fig. 4, the switch arms 46a, 46b and 46c are set on either of the contacts 43a, 43b, 43c or 45a, 45b, 45c, depending on whether the article to be selected does or does not contain the color component detected by the associated bridge circuit 31, 40 and 41. For example, if it is desired to obtain articles having red and blue coloring, but no green coloring, the switch arms 46a and 46c associated with the red and blue bridges 31, 41 are set on contacts 43a and 43c. The switch arm 46b associated with green bridge 40 is set on contact 45b. Therefore, when an article of the desired red and blue coloring passes into the projected beam 13 (Fig. 1), the reflected red and blue rays in beam 15 energize the red and blue bridge circuits 31, 41, producing voltages that exceed the threshold values. These voltages fire the Schmitt triggers 42a, 42c; and the trigger outputs are amplified, and applied to the AND circuit 47. The green bridge 40 will not be energized since the article absorbs the green components of the projected light 13. Therefore the Schmitt trigger 42b output is zero, which is inverted by the inverting circuit 44b to provide a signal to the AND circuit 47. With all three inputs to the AND circuit 47 energized, the AND circuit produces an output which is amplified and applied to the relay 48, causing the solenoid-actuated air valve 50 to open and permit compressed air to blow the article into the receptacle 53 of desired articles. On the other hand, if the article in the beam 13 does not contain the desired coloring, e.g., red, the red bridge 31 does not fire the Schmitt trigger 42a, and no signal is presented to switch arm 46a. Accordingly, the AND circuit 47 does not produce an output, and the valve 50 is not opened, permitting the article to fall freely into the receptacle 54 of rejected articles.

It will readily be apparent that the above-described apparatus may be modified considerably without departing from the essential principles thereof. For an example, the light source 14 of Fig. 1 may be incorporated into the center of the photo converter 16, so that the projected light (13) and reflected light (15) traverse the same path, thereby eliminating some of the differences in intensity of reflected light (15) due to irregularities in the surfaces of the articles 10. For another example, the solenoid-actuated air valve 50 of Fig. 1 may be replaced by a solenoid-actuated light-weight baffle having two stable positions (flip-flop action). These and similar other modifications obviously do not alter the basic principles of the apparatus.

Myron C. Selby

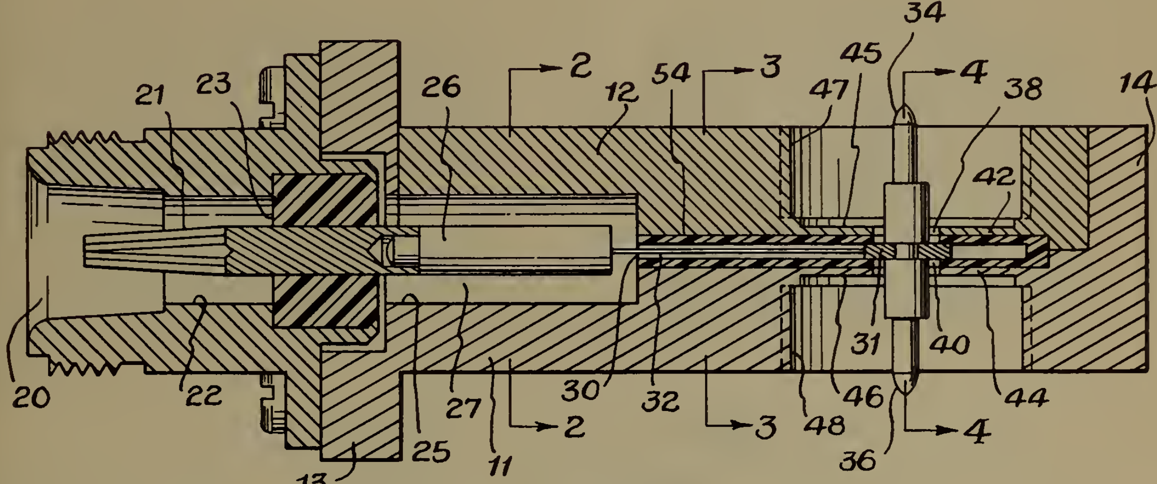


Fig. 1

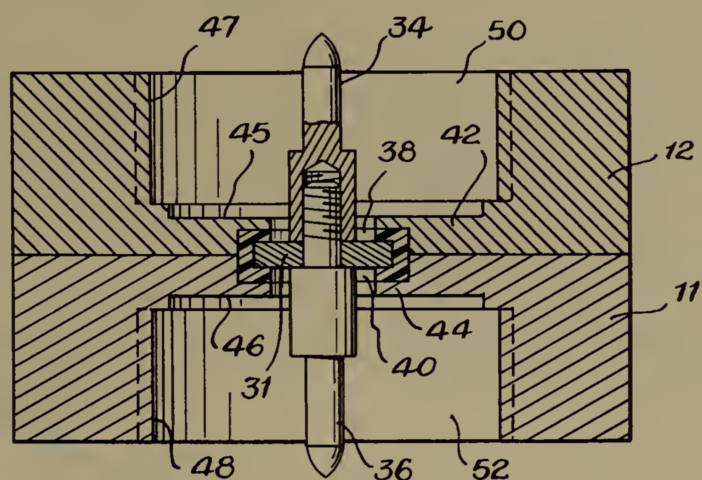


Fig. 4

COAXIAL T FOR RADIO-FREQUENCY VOLTMETER CALIBRATIONS

Myron C. Selby

Fig. 2

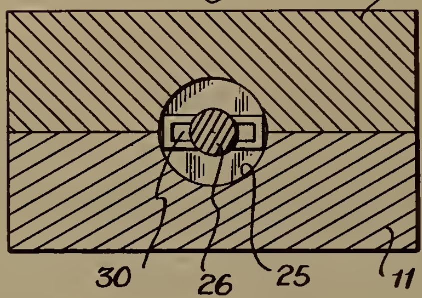
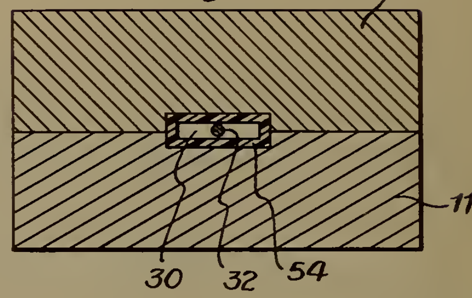


Fig. 3



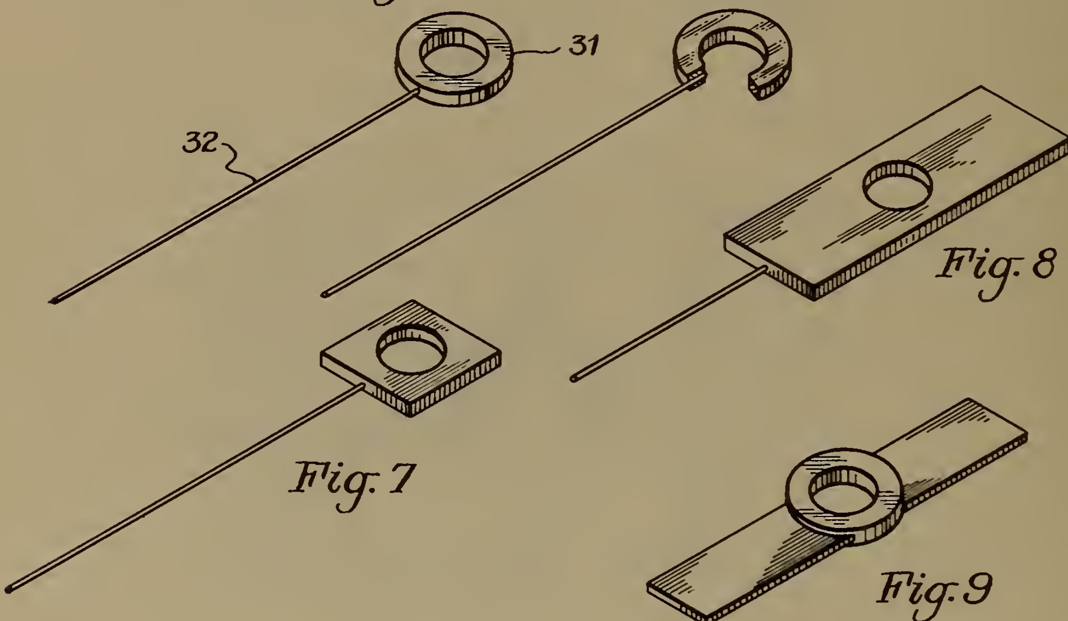


Fig. 5

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Tech. Note No. 263, June 18, 1965

COAXIAL T FOR RADIO-FREQUENCY VOLTMETER CALIBRATIONS

Myron C. Selby

In the calibration of an unknown radio-frequency voltmeter against a standard voltmeter, it is necessary to connect both voltmeters to an adjustable radio-frequency voltage source. A coaxial T is usually employed for this purpose, the voltmeters being connected to the arms of the T, and the adjustable voltage source to the stem of the T. To achieve high precision and accuracy, the coaxial T should present idential voltages at each arm connector, and should not introduce unwanted modes into the applied voltage waveform. Furthermore, since it often is impractical or undesirable to match the (high) input impedances of the voltmeters to the (low) characteristic impedances of the arms of the T, the T preferably should have physically short arms to avoid the formation of large standing waves in the T. The coaxial T shown in Figs. 1-4 possess these desired characteristics.

The coaxial T of Figs. 1-4 has a rectangular housing formed from two superimposed metal plates 11 and 12. The lower plate 11 has an integrally-formed front flange portion 13 and an integrally-formed back protective portion 14. The upper plate 12 fits between these front and back portions 13, 14, and is suitably aligned and secured to the lower plate 11 as by screws (not shown).

The front flange portion 13 of lower plate 11 is provided to receive the input or stem connector 20, which is a conventional coaxial connector having an inner conductor 21, outer conductor portion 22, and insulating sleeve 23. The inner conductor 21 projects a short distance through a hole in the flange 13 and into a circular bore 25 that is formed in the adjacent surfaces of the superimposed plates 11, 12 (see Fig. 2). A short conductor 26 that is axially aligned with inner conductor 21 is secured to the end of the inner conductor 21, whereby the conductor 26 and bore 25 provide a short coaxial line 27. Any other suitable input configuration into the T may be employed in place of the section consisting of line elements 25 and 26.

Tech. Note No. 263, June 18, 1965

The coaxial line 27 communicates with an axially-aligned passageway 30, which, as shown in Fig. 3, has a rectangular cross section. The width of the passageway 30 preferably is less than the outer diameter (bore 25) of the coaxial line 27, and the height of the passageway 30 preferably is very much less than the outer diameter, so that the passageway 30 constitutes a waveguide beyond cutoff for any higher order modes introduced along the coaxial line 27. Disposed in the far end of the passageway 30 is a thin circular metal diaphragm 31 (see Fig. 5) which is connected to the center conductor 26 of the coaxial line 27 by a thin axially-aligned wire 32. As shown in Figs. 1 and 4, a pair of pins 34, 36 project orthogonally from opposite sides of the diaphragm 31 and extend through concentrically-arranged irises 38, 40. The irises 38, 40 are centrally located in thin circular outer diaphragms 42, 44 that are defined by the adjacent surfaces of the superimposed plates 11, 12 (and grooves forming the passageway 30) and by the bottom surfaces 45, 46 of a pair of threaded holes 47, 48. The threaded holes 47, 48 are formed in the plates 11, 12 to provide concentric outer connector elements for the pins 34, 36. The resultant coaxial connectors 50, 52 are the arm connectors of the coaxial T.

The diaphragm 31 and its connecting wire 32 are insulated from the walls of the passageway 30 by four thin layers of insulation 54 that line the passageway 30, as shown in Figs. 1 and 3. Adjacent the pins 34, 36 the insulation 54 is apertured with holes of the same diameter and axial alignment as the irises 38, 40 (see Figs. 1 and 4), whereby the pins 34, 36 project freely from the inner diaphragm 31 through the outer (grounded) diaphragms 42, 44. In this manner, the electromagnetic wave energy in the passageway 30 (waveguide beyond cutoff for higher order modes) is evenly divided and transmitted over very short distances to the arm connectors 50, 52. Since the path lengths from the inner diaphragm 31 through the outer diaphragms 42, 44 are very short, relative to the guide wavelength of the highest frequency voltage to be applied to the stem connector 20, no large destructive standing waves can be set up in the coaxial T, enabling the T to operate into relatively high impedance voltmeters and the like.

For good reproducibility over a large bandwidth, the diaphragms 31, 42 and 44 should be flat, uniform, and parallel to each other, with the inner diaphragm 31 spaced midway in the passageway 30 between the outer diaphragms 42, 44. The axes of the pins 34, 36, irises 38, 40 and threaded holes 47, 48 should all be coextensive and perpendicular to the planes of the diaphragms 31, 42, 44.

Figs. 6-9 illustrate several alternative embodiments of the inner diaphragm 31, which embodiments provide various transverse and axial field patterns of the wave energy transferred from the inner diaphragm 31 through the irises 38, 40.

A NORMAL INCIDENCE INTERFEROMETER

Jurgen R. Meyer-Arendt

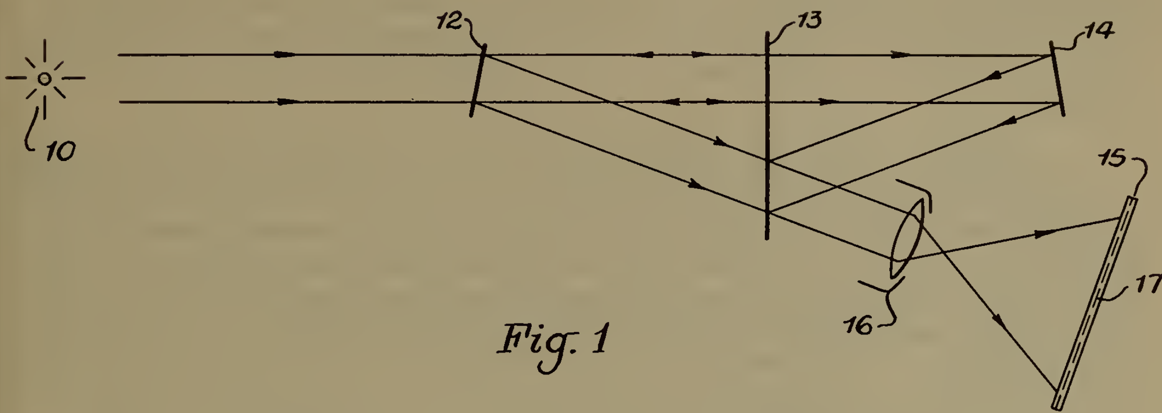


Fig. 1

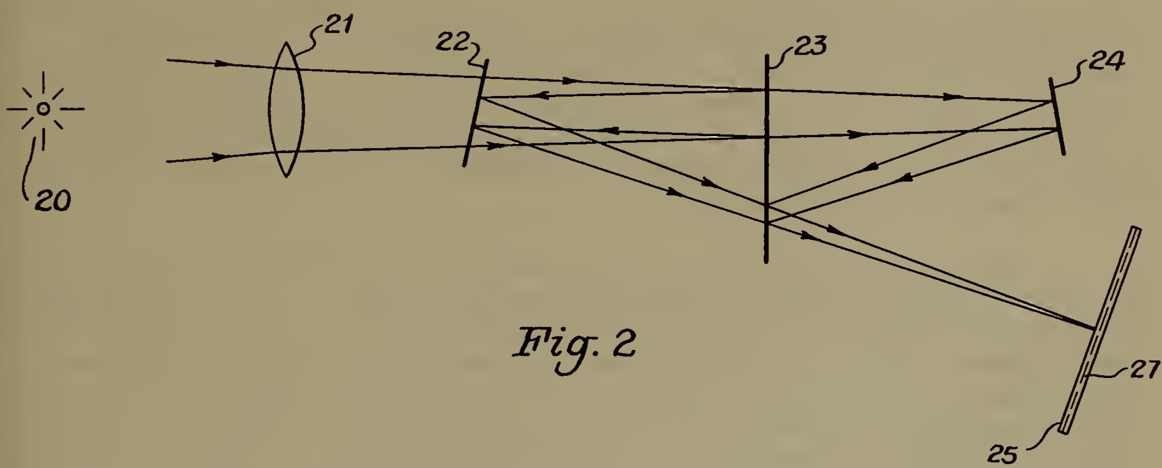


Fig. 2

A NORMAL INCIDENCE INTERFEROMETER

Jurgen R. Meyer-Arendt

The light in this interferometer is incident on the primary beamsplitter in a direction normal to the beamsplitter. Hence the interferometer is almost insensitive to fluctuations in the angle of arrival of the light, especially when used as part of an astonomical telescope of long focal length.

Consider first the operation of the interferometer when accepting a collimated bundle of light from source 10 in Fig. 1. The light passes through beamsplitter 12 and is incident on primary beamsplitter 13 in a direction normal to 13. The light is divided into two portions by beamsplitter 13. One portion is reflected back to beamsplitter 12 which in turn reflects part of that light through 13 toward screen 15 in the plane of observation. The other portion of the light is transmitted through beamsplitter 13, reflected by the plane mirror 14, reflected again by 13 and is brought to interference on screen 15. The short focal-length lens 16 is used to widen the field within which the interference fringes become visible.

Now consider the operation of the interferometer when accepting a converging bundle of light from source 20 in Fig. 2. The light is brought to focus on screen 25 by means of lens 21. Beamsplitters 22 and 23 and mirror 24 function in the same manner as their corresponding parts in Fig. 1. The converging rays of light will then coincide and produce interference fringes, in addition to a real image of source 20, in the plane of screen 25.

The principal purpose of the interferometer is to provide a means for measuring differential phase fluctuations such as occur on passage of light from a star or a terrestrial light source through the turbulent atmosphere. Because of the virtual insensitivity of the interferometer described to variations in angle of arrival of the star light, the instrument does provide a reliable and easily adjustable means for obtaining numerical values for such phase fluctuations which, in turn, give information about the turbulence characteristics of the atmosphere and its effect on optical propagation. Measurements of this kind can be carried out in the following way.

Tech. Note No. 263, June 18, 1965

Grid patterns 17 and 27, each coinciding with a related interference pattern, are located in the plane of screens 15 and 25, respectively. A collecting lens and photodetector, not shown, are placed behind screen 25, for example. The output of the photodetector is zero when interference occurs, and the interference fringes on screen 25 coincide with grid pattern 27. The telescope, whose output is applied to, or which is identical with, lens 21, may be adjusted so that zero output of the photodetector will occur when the point image of the object is exactly in the plane of grid 27.

Finite values of photocurrent, on the other hand, will occur when the interference and grid patterns do not match, a condition which, proper alignment provided, will occur when phase fluctuation differences are present. Since a minimum of differential phase fluctuations over an extended telescope aperture is necessary for obtaining sharp photographs of distant celestial or terrestrial objects, the instrument may be utilized to trigger a camera shutter to take photographs of the object when the atmospheric conditions for transmitting images are optimal.

U.S. GOVERNMENT PRINTING OFFICE : 1965 O—777-656

UNITED STATES
GOVERNMENT PRINTING OFFICE
DIVISION OF PUBLIC DOCUMENTS
WASHINGTON, D.C. 20402

OFFICIAL BUSINESS